

THE
PSYCHOLOGICAL BULLETIN

A DESCRIPTION OF THE AFFECTIVE CHARACTER
OF THE COLORS OF THE SPECTRUM.

BY NEWTON A. WELLS,

Professor of Architectural Decoration, University of Illinois.

It is possible to distinguish in consciousness two kinds, or qualities, of objectivity with their corresponding phases of subjectivity. One is that objectivity which results from the focusing of attention upon the stimulating causes of consciousness; the other is an objectivity, often called subconscious, which results from a response of the sensorium to a stimulus upon which the attention may, or may *not*, be focused.

For example; I may be reading in a richly furnished and tastefully decorated interior. Although my attention is upon the subject-matter of my reading, I am still pleasantly conscious of the luxury and harmony of the surroundings which attracted my attention upon entering.

This subconscious objectivity, stimulated by the presence of sense-impressions outside the focus of attention, we shall designate as *mood*, in order to distinguish it from the ideation of definitely focused attention.

It is not probable that many people realize the enormous influence which is exercised upon human felicity by the presence of agreeable, or disagreeable sensory stimuli. Among such stimuli color plays a very important rôle. For many years the writer has believed that different colors stimulate, in the majority of sensibilities, corresponding differences of mood. (Will the reader pardon me for continuing in the first person?) Feeling about color as I did, I began to be curious to know if others felt the same. My own feeling is as follows: *crimson*, or deep red with a trace of blue in it, when standing alone, or seen in large quantity, always gave me vague impressions of passion, rage, blood, etc.; *scarlet*, or red with a trace of yellow, the blare of

trumpets, etc.; *deep-orange*, the heat of flame, soon excites irritation to a feeling of suffocation; *orange-yellow*, warm, glowing, lively; *yellow*, joyous, gay, merry; *yellow-green*, cheerful, smiling; *green*, peaceful, neither sad nor cheerful; *blue-green*, sedate, sober; *blue*, cool tranquillity; *violet-blue*, stern, hard, unyielding, gloom; *violet*, subduing, serious to the point of melancholy; *purple*, stately, pompous, impressive.

Analyzing my own feelings, or mood affection, I found that the hues of the spectrum from red to yellow-green act as excitants, this excitation being most intense at red and diminishing in intensity until the mood affection became tranquil at green. At blue, a grave mood reaction became noticeable, then descending to solemnity in violet.

Wishing to learn if other sensibilities were affected in a like manner, I several years ago commenced making a series of experiments upon the members of my various classes in drawing, design, and art-history. These experiments have extended over a period of about six years, in which more than two hundred and fifty individuals have been examined. The results based upon the sixty-three individuals examined recently, and herewith given, do not materially differ from those previously examined.

I am aware of experiments already performed and looking toward like results; such, for example, as the exposure of the subjects for a period of fifteen minutes to the stimulus of a given hue which was thrown upon a screen in a darkened room by means of a lantern projection. Such a form of experiment seems objectionable because the color stimulus thus applied, transcends in intensity all of the ordinary experiences of everyday life. It also concentrates attention upon a meaningless sense-impression for a length of time which wearies the sensibilities thus over-stimulated, to a point where normal mood reaction becomes altogether improbable. The desirable thing to learn is the affective character of a given color stimulation under normal or every-day conditions. It has seemed best, therefore, to follow the procedure herewith described.

DESCRIPTION OF EXPERIMENT A.

A	7604
	Crimson
a	
B	Scarlet
	6867
C	6567
	6208
D	Deep-orange
	Orange-yellow
E	5889
	Yellow
F	5808
	Yellow-green
G	5350
	Green
H	5289
	Blue-green
I	5000
	4861
J	Blue 4732
	B. Violet 4307
K	Violet
	4059
L	3933
	Purple
M	3700 ?

The solar spectrum was divided into twelve separate hues, the names and approximate location of which are given in the diagram.

These hues were painted to as full saturation as possible with aniline dyes upon two-inch squares of white water-color paper. These squares were then mounted upon a large sheet of neutral gray, in a horizontal row, about three inches apart, following the order of the spectrum. Each hue, upon the color chart thus formed, was designated by a number printed above it on the gray back-ground, beginning at the red end of the spectrum.

The use of a neutral gray ground is preferable as it avoids the extreme contrasts of the dark hues with white, also of the light hues with black. It is also a well-known fact to all colorists that saturated as well as non-saturated colors show to their fullest value upon a gray ground. Unbalanced, or exaggerated contrasts of the juxtaposed hues are also avoided by their arrangement in their spectral order.

The color chart being hung before the class, the following list of words, always in the order here given, so as to avoid inferences, was then written upon the black-board

quiet	exciting	dépressing	peaceful
sad	solemn	loud	dignified
lively	neutral	heavy	gloomy
sombre	gay	light, or airy	energetic
restful	cheerful	noisy	dainty

After distribution of slips of blank paper the members of the class were instructed to designate each of the twelve colors by number and to write opposite each number some word from the list which would express the feeling or mood suggested by the color represented by that number. They were also given the privilege of employing any words not in the list, which might better express their feeling. All were cautioned against employing such purely subjective descriptions as 'pleasant' and 'unpleasant,' or 'agreeable' and 'disagreeable,' since it was not so much a question of *what* they liked and disliked,

as *why* they liked, or disliked. They were also cautioned against any consultation, or comparison of views, since that would vitiate all individuality of opinion. It will be noticed that the list of words is written in so confused a manner as to give no hint as to their classification into groups of *energized*, *tranquilized* and *subdued* moods. In case a color suggested no mood feeling whatever, the individual was requested to indicate the fact by drawing a dash line against that number. After being filled in, the slips were signed by their respective authors and collected for tabulation. Upon inquiry it was learned that only one individual out of the sixty-three whose replies are here tabulated had ever heard of a like psychological examination. This was Mr. B—y, who described to me the lantern projection experiment already referred to. The people examined came mostly from well-to-do suburban homes of the Middle West, they were also students scattered among the various colleges of engineering, science, literature and arts, and agriculture. But a very small proportion of them were what is known as 'art students.'

EXPERIMENT A.

Tabulated Results for the 32 Men and 31 Women Examined.

GROUP I.	GROUP II.	GROUP III.
Mood reactions indicating some kind and degree of exciting influence.	Mood reactions indicating some kind and degree of tranquilizing influence.	Mood reactions indicating some kind and degree of subduing influence.
<i>Replies for Crimson.</i>		
rich, showy.... 4	quiet..... 3 A. S. R.	dignified..... 2
exciting..... 6	restful..... 1 W.	impressive 2
energetic..... 2	4	depressing..... 2 Hs.
loud 5	4 men	sombre 3 Ry. A. C.
lively 8	0 women	heavy 6 V.
noisy 6	Corrected 0	15
cheerful..... 6 Wg.		10 men
gay..... 1		5 women
gaudy..... 2		Corrected 10
warm 2		6 men, 4 women
danger..... 1 D.		
gay, heavy..... 1 P.		Total, 63 replies
44		Corrected 51 replies
18 men		
26 women		
Corrected 41		
16 men, 25 women		

Replies for Scarlet.

energetic..... 4	quiet..... I V.	heavy I Hs.
gay.....10	restful..... I C.	depressing..... I Br.
exciting17	neutral I S.	solemn..... 2 Ry. A.
striking..... 1	$\frac{3}{3}$	$\frac{4}{4}$
cheerful 3	3 men	2 men
lively 3	0 women	2 women
loud..... 7	Corrected 0	Corrected 0
tiring..... 1		
noisy..... 6		Total 63 replies
gaudy..... 2		Corrected 56 replies
warm 1		
rich, warm..... 1		
$\frac{56}{56}$		
27 men		
29 women		

Replies for Orange (deep).

cheerful 7	quiet I Hk.	sad..... I A.
loud.....19	neutral..... I St.	depressing..... I W.
lively 5	$\frac{2}{2}$	$\frac{2}{2}$
exciting10	I man	2 men
gaudy 1	I woman	0 women
noisy 9	Corrected 0	Corrected 0
gay 4		
bright..... 1		Total 63 replies
restless 1		Corrected 59 replies
garish 1		
rich, glowing..... 1		
$\frac{59}{59}$		
29 men		
30 women		

Replies for Orange-yellow.

gay12	neutral2	sad..... I A.
lively.....11	peaceful2	heavy..... I Wg.
frivolous 1	restful I	$\frac{2}{2}$
garish 1	mellow I	I man
noisy..... 3	$\frac{6}{6}$	I woman
uneasy 1	2 men	Corrected 0
cheerful 9	4 women	
light 1		Total 63 replies
loud 4		Corrected 61 replies
exciting 1		
bright..... 2		
energetic..... 3		
gaudy 3		
light, airy..... 3		
$\frac{55}{55}$		
29 men		
26 women		

Replies for Yellow.

light, airy.....36
noisy..... 2
cheerful 9
gay..... 4
exciting 1
joyous..... 1
53

29 men
24 women

neutral1
quiet1
restful2
peaceful2
6
1 man
5 women

depressing.....1 He.
bilious1 J.
sombre.....1 St.
dignified1 Ha.
4

2 men, 2 women
Corrected 0

Total 63 replies
Corrected 59 replies

Replies for Yellow-green.

lively..... 4
light, airy..... 8
cheerful 2
14

7 men
7 women

neutral 9
quiet..... 6
restful11
cool..... 2
peaceful..... 8
pale..... 1
2
39

17 men
22 women

depressing..... 4 Hn. R.
sombre 2 G. Gn.
dull 1
gloomy..... 2 V. P.
sickly..... 1
10

8 men
2 women
Corrected 4 men, 1 woman

Total 63 replies
Corrected 58 replies

Replies for Green.

light..... 1
loud 5
noisy 4
cheerful..... 3
sprightly..... 1
exciting..... 4
gaudy..... 1
gay 3
energetic..... 2
garish..... 1
lively..... 3
28

12 men
16 women

restful11
quiet..... 5
peaceful..... 8
4
neutral..... 2
cool..... 1
tender..... 1
32

17 men
15 women

depressing.....2 G. Hk.
sombre.....1 R.
3

3 men
0 women
Corrected 0

Total 63 replies
Corrected 60 replies

Replies for Blue-green.

gay..... 5
loud11
lively..... 4
light 2 Hk. Hn.
exciting..... 2
cheerful..... 2
strong..... 1
energetic... 4
noisy..... 2
gaudy..... 1
34

peaceful..... 8
restful.....10
quiet..... 1
3
neutral..... 1
23

20 men
3 women

depressing1
solemn.....1
sad2
peaceful, sombre1
gloomy.....1
6

4 men
2 women

Total 63 replies
Corrected 61 replies

8 men, 26 women

Corrected 32

6 men, 26 women

Replies for Blue.

irritating..... 2
 loud..... 2
 light, airy 1 V.
 gay..... 3
 energetic 2
 strong..... 1
 exciting 1
 12

quiet 4
 peaceful..... 4
 restful..... 4
 ————— 4
 neutral..... 5
 21

dignified..... 10
 gloomy 3
 sombre..... 4
 sad..... 1
 solemn..... 6
 depressing..... 2
 heavy..... 3
 impressive..... 1
 30

4 men

8 women

Corrected 11

3 men

8 women

15 men, 15 women

Total 63 replies

Corrected 62 replies

Replies for Violet-blue.

No replies in
 this group

peaceful..... 6
 restful..... 6
 quiet..... 2
 neutral..... 3
 17

9 men

8 women

solemn..... 7
 heavy..... 10
 dignified..... 4
 sombre..... 5
 sombre, rich 2
 sombre, sad..... 2
 dull 2 D.
 sad..... 6
 gloomy..... 7
 depressing..... 1
 46

Total 63 replies

Corrected 62 replies

23 men

23 women

Corrected 45

22 men, 23 women

Replies for Violet.

energetic 1 R.
 1 man
 Corrected 0

neutral..... 2 G.
 no effect..... 1 R.
 restful..... 1
 restful, elegant. 1
 quiet..... 3
 8

3 men

5 women

Corrected 6

1 man, 5 women

gloomy 9
 solemn..... 7
 solemn, peaceful .. 1
 depressing 6
 richness..... 1
 sad..... 8
 dignified 8
 heavy..... 6
 sombre 5
 impressive 3
 54

Total 63 replies

Corrected 61 replies

28 men

26 women

Replies for Purple.

loud.....I	peaceful.....2 Wt.	solemn..... 4
gay.....4 P. C. G. H.	neutral.....1 Go.	dignified.....22
irritating.....I	3	rich, dignified... 1
energetic.....I	1 man	sombre..... 5
lively.....I L.	2 women	impressive..... 6
lively, dignified 1 Wg.	Corrected 1 woman	depressing..... 4
9		heavy..... 3
4 men		sad..... 2
5 women		sorrow..... 1 D.
Corrected 3		gloomy..... 1
0 men		nauseating..... 2 J. By.
3 women		51
Total 63 replies		27 men
Corrected 52 replies		24 women
		Corrected 48
		24 men
		24 women

Summary of Results for Experiment A.

Group I. Excitation.	Group II. Repose.	Group III. Gravity.
Crimson 44	Crimson 4	Crimson 15
Scarlet 56	Scarlet 3	Scarlet 4
Deep-orange 59	Deep-orange 2	Deep-orange 2
Orange-yellow 55	Orange-yellow 6	Orange-Yellow 2
Yellow 53	Yellow 6	Yellow 4
Yellow-green 14	Yellow-green 39	Yellow-green 10
Green 28	Green 32	Green 3
Blue-green 34	Blue-green 23	Blue-green 6
Blue 12	Blue 21	Blue 30
Violet-blue 0	Violet-blue 17	Violet-blue 46
Violet 1	Violet 8	Violet 54
Purple 9	Purple 3	Purple 51

EXPLANATIONS AND CORRECTIONS OF ABNORMAL REPLIES.

While tabulating the above results some very contradictory and unusual replies were observed. The individuals making these unusual replies were subsequently examined separately for color perception by the Nagel method, from which the following facts appeared.

1. There appears to be quite a variety in the *degrees of development* of color perception.

2. This development is more complete among women than among men.

3. This deficiency is usually to be found in the perception of *reds* and *greens*.

4. This deficiency, or weakness of color perception, is usually accompanied by either *aversion* or *indifference* to that region of the spectrum in which the deficiency occurs.

These facts are clearly brought out by an examination of the following records of the individuals examined.

RECORDS OF TESTS FOR ABNORMAL COLOR PERCEPTION MADE BY THE
NAGEL *Tafeln*. 17 MEN AND 6 WOMEN.

Mr. V. . . ., who called crimson 'heavy,' scarlet 'quiet,' yellow-green 'gloomy,' and green 'loud.'

Record: A12, saw olive-green and another color which he could not name but thought it some kind of a greenish, or bluish cast. Called B3 'carmine and light brown.'

Called B2 the same and saw no difference in the red and brown-red. Saw but two differences of hue in B1, which he called russet and yellow-green. Was very uncertain as to the gray and the greenish-yellow in A14. *Abnormal to red and green.*

Mr. R. . . ., who called crimson 'quiet,' yellow-green 'depressing,' and green 'sombre'.

Record: Saw but one value of red in A3, 'all alike.' The same also for B2. Could not distinguish gray from green on A6. *Abnormal to red and green.*

Mr. D. . . ., who called crimson 'danger,' yellow-green and blue '——,' and violet-blue 'dull.'

Record: Mistook the gray in A9 and A15 for greens twice. Failed to detect any difference of value in the red and red-brown on B1. *Abnormal to red and green.*

Mr. W. . . ., who called crimson 'restful,' and green 'neutral.'

Record: Saw green and, after much hesitation, saw two kinds of brown on B2. Saw but one value of green and one of brown on B1. Saw red, green and hesitated to name the other color, on A7. Invariably hesitated over dulled reds and often confused green and gray. *Abnormal to red and green.*

Mr. G. . . ., who called violet 'neutral,' purple 'gay,' yellow 'noisy,' yellow-green 'sombre,' and green 'depressing.'

Record: Saw no differences of value in the reds of A3. Saw the grays of A9 as greens. Repeated both of these errors several times. *Abnormal to red and green.*

Mr. S. . . ., who called crimson 'quiet,' scarlet 'neutral.'

Record: Saw but one value of green and one of brown on B1. Made no errors on green and gray, but omitted A8, and A11, on the first call for all plates having green, or greenish points, insisting that those plates contained blue points. At a subsequent call for greens A8, A11, and A13, were omitted as having blue points instead of green. Finally when called upon to select all plates having blue points, he omitted A13 which he had formerly called blue. *Abnormal to red and green.*

Mr. A. . . ., who called scarlet 'sombre,' deep-orange 'sad.'

Record: Saw but one value of brown in A12. But one value of red in

- A15. But one value each of brown and greenish-brown in B1. Said that B3 and B2 were identical in coloring. *Abnormal to red and green.*
- Mr. P. . . . , who called yellow-green 'gloomy, solemn.'
- Record: Showed a keen perception for all reds. Frequently mistook gray for green but never green for gray. Greatest trouble with yellow-greens. Called A1 'red and two shades of green.' Called A9 'two shades of muddy color,' finally 'gray.' Called A11 'two blues and a muddy green.' A rare case of which I am still doubtful. Should think abnormal to yellow.
- Mr. H. . . . k, who called deep-orange 'quiet,' yellow 'exciting,' green 'depressing,' blue-green 'light.'
- Record: Very slow and hesitant in choosing reds but finally correct. Called B2 'red and one muddy-green and one reddish-green.' Called B3 the same as B2. Called B1 'a grass-green, a reddish-green and a muddy-green.' At first classed A9 with greens but finally rejected it. *Abnormal to red and green.*
- Mr. W. . . . t, who called yellow 'neutral,' blue-green '——,' purple 'peaceful.'
- Record: Frequently mistook green for gray and gray for green. Hesitated to name A9. Saw but two values of hue in B1. Saw but one value of red and one of brown in B3. *Abnormal to red and green.*
- Mr. R. . . . y, who called crimson 'sombre,' scarlet 'solemn,' violet 'blank.'
- Record: Called A15 'two reds and one green.' In choosing greens, overlooked A8 and included A15 and A16.
- In choosing grays, included A15. Uncertain as to green and gray in A16. Very hesitant on B1; also on B2. Failed to see different values of red in the degraded reds and red-browns. *Abnormal to red and green.*
- Mr. H. . . . e, who called yellow and yellow-green 'depressing.'
- Made no obvious errors under the severest tests, hesitating only upon the very closely related grays and greens. Confessed to an unaccountable antipathy for yellows.
- Mr. H. . . . n, who called yellow-green 'depressing,' and green 'noisy.'
- Record: Called B2 'one red and two shades of brown;' B3 the same as B2. Called B1 'two shades of brown and two of green.' Called A12 the same as B1. Called A1 'a red and a green.' *Abnormal to red and green.*
- Mr. B. . . . a, who called yellow-green 'neutral,' green and blue-green 'blank,' blue 'depressing,' violet-blue 'restful.'
- Record: Made frequent errors by confusing greens and grays. Called A6 different shades of the same color at first and then corrected by announcing 'green, yellow-green, and—' hesitated to name the other color and gave it up. When asked for reds, at first included A12 and B1, but finally rejected them, calling the browns 'greenish-reddish.' *Abnormal to red and green.*
- Mr. C. . . . , who called scarlet 'quiet,' green 'exciting,' purple 'gay.'
- Record: Included A6 among the gray, but rejected it when questioned about it; *i. e.*, asked to point out the gray. Called A11 'light gray-blue, deeper blue, and greenish-brown.' Called A5 'four shades of green.' Called B2 and B3 alike, 'one red and two browns.' Called B1 'two shades of green and two of brown.' Saw no gray in A6, A7, A14, A15 and A16. *Abnormal to red and green.*

Mr. J. . . ., who called yellow 'bilious,' yellow-green the same, and purple 'nauseating.' Normal perception but confessed to an aversion to yellow on account of being confined in a yellow-papered room during an illness.

Mr. B. . . . y, who called purple 'nauseating.' Normal perception but had become nauseated during a long test for color reaction by the method of the darkened room and the lantern projections. The nausea came on during exposure to purple.

Miss G. . . . n, who called purple 'neutral,' green and crimson both 'lively.'

Record: Called B2 'red and tan,' but finally changed the 'tan' to a 'shade of red.' Called B3 'red, brown and tan,' naming the 'tan' with much hesitation. Called B1 'greenish-gray and a brown'; recognized but one value of the brown, or the gray-green. *Abnormal to red and green.*

Miss G. . . ., who called yellow-green 'sombre,' green 'exciting,' blue 'gay.'

Record: Selected A9 and A7 as the only plates having gray and no green. In choosing greens omitted A8 as having blue but no green. Made no errors in reds. A doubtful case.

Miss H. . . . s, who called crimson 'depressing,' scarlet 'heavy,' purple 'gay,' yellow 'rich and dignified,' green 'cheerful.'

Record: Saw but one value of red in A15. Could not decide as to the gray, or green, in A7 and A15. Saw one red and two browns in B2. One red and three browns in B3. *Abnormal to red and green.*

Miss W. . . . g, who called yellow-green 'heavy,' purple 'lively, dignified.'

Record: Saw two browns and two reds in B2. Three browns and two reds in B3. Saw three reds in A3. Called A15 'three of old-rose, two of olive-green.' Called A6 'olive-green, gray-green, and grass-green.' Made numerous errors in distinguishing greens from grays. *Abnormal to red and green.*

Miss L. . . ., who called orange-yellow 'neutral,' purple 'lively,' and crimson 'cheerful.'

Record: Called B1 'two of green and one shade of brown.' Frequent errors in distinguishing grays from greens. *Abnormal to red and green.*

Miss S. . . . t, who called orange-yellow 'neutral,' yellow 'sombre,' and crimson 'heavy.'

Record: Confused yellow-greens with blue-greens by calling them 'different shades of the same color. Made no obvious errors on the reds. Called B1 'bluish and brownish greenish,' after long hesitation. A case which the Nagel method does not seem to me to clearly identify as abnormal to red and green; yet, a case which is clearly abnormal to hues that contain yellow.

ANALYSIS OF CORRECTED RESULTS OF EXPERIMENT A.

In the following tabulation of corrected results, those abnormal replies (which are indicated in the first tabulation by the initials of the persons making them) have been eliminated.

Group I., in which the constant of objectivity is *excitation*.

Crimson

16 men

25 women

41 total

Group II., in which the constant of objectivity is *repose*.

Group III., in which the constant of objectivity is *gravity*.

6 men

4 women

10 total

Scarlet		
27 men		
29 women		
<u>56 total</u>		
Deep-orange		
29 men		
30 women		
<u>59 total</u>		
Orange-yellow		
29 men	2 men	
26 women	4 women	
<u>55 total</u>	<u>6 total</u>	
Yellow		
29 men	1 man	
24 women	5 women	
<u>53 total</u>	<u>6 total</u>	
Yellow-green		
7 men	17 men	4 men
7 women	22 women	1 woman
<u>14 total</u>	<u>39 total</u>	<u>5 total</u>
Green		
12 men	17 men	
16 women	15 women	
<u>28 total</u>	<u>32 total</u>	
Blue-green		
6 men	20 men	4 men
26 women	3 women	2 women
<u>32 total</u>	<u>23 total</u>	<u>6 total</u>
Blue		
3 men	13 men	15 men
8 women	8 women	15 women
<u>11 total</u>	<u>21 total</u>	<u>30 total</u>
Violet-blue		
	9 men	22 men
	8 women	23 women
	<u>17 total</u>	<u>45 total</u>
Violet		
	1 man	28 men
	5 women	26 women
	<u>6 total</u>	<u>54 total</u>
Purple		
0 men	1 woman	24 men
3 women		24 women
<u>3 total</u>		<u>48 total</u>

Inspection of the above tabulation indicates that hues in which red is the dominant factor, induce a mood reaction of an exciting character; this excitation beginning to appear, for a few sensibilities, in purple, and increasing in strength until it becomes universal in scarlet

and deep-orange; thence decreasing until it becomes tranquillity, for the majority of sensibilities, in yellow-green. From this point on there is a curious rise toward excitement, which becomes pronounced in blue-green; thence the descent passes gradually down through blue and violet-blue to culminate in almost universal gravity in violet.

One of the most interesting phenomena appearing in the results of experiment *A*, is the contradictory nature of the replies for the middle, or *tranquil* portion of the spectrum. These very contradictions are, however, one of the best evidences that the colors in this region are not of sufficient affective energy to induce reactions of a definitely felt character for the majority of sensibilities.

Believing that the combined stimulus of all those colors suspected of being respectively *exciting*, *tranquilizing* or *repressing*, in affective character, would become cumulative, if simultaneously exhibited, the following experiment was undertaken.

EXPERIMENT B.

After the results for experiment *A* had been tabulated and compared, the color chart used in that experiment was cut vertically into three portions, the first portion containing crimson, scarlet, deep-orange, orange-yellow and yellow; the second portion containing yellow-green, green, blue-green and blue; the third portion containing violet-blue, violet, and purple. These portions were placed upon the black-board about ten feet apart so that when the eye rested upon one of the groups the others would not fall within the field of direct vision. The same list of words was also written upon the board with the following additional list of qualifying adverbs in anticipation of the more energetic reactions which might result from the cumulative stimulus of the color groups, as compared with that of single hues. The members of the class were instructed to employ any qualifying words which they chose in describing their mood feeling toward each group.

LIST OF ADDITIONAL ADVERBS.

richly	sadly	tranquilly	daintily
sedately	gaily	impressively	cheerfully
pompously	quietly	gorgeously	depressingly

Only 37 of the students who had taken part in the previous experiment were present at this time, 12 men and 25 women.

Replies for Group containing crimson, scarlet, deep- orange, orange-yellow and yellow.	Replies for Group containing yellow-green, green, blue- green, and blue.	Replies for Group containing violet, blue-violet, and purple.
---	--	---

Men.

richly gay..... 3	quietly peaceful... 3	sedately sad.....1
gorgeously rich... 3	peacefully tender.. 2	depressingly sad... 1

cheerfully gay..... 2
 gorgeously pomp-
 ous..... 1 * J.
 gaily energetic... 1
 cheerfully ener-
 getic..... 1
 gay 1
 Total..... 12
 Corrected 11

quietly tranquil.... 2
 cheerfully bilious. 1 * J.
 tenderly faded.... 1
 daintily peaceful... 1
 peaceful..... 1
 sadly depressing... 1 * R.
 Total..... 12
 Corrected 10

pompously rich..... 2
 repressingly dull.... 1
 richly sad..... 2
 somberly dignified 1
 sedate..... 2
 vigorously gor-
 geous..... 1 * P.
 vigorously gay..... 1 * R.
 Total..... 12
 Corrected 10

Women.

gorgeously rich... 6
 gorgeously gay... 4
 gorgeously vigor-
 ous..... 2
 cheerfully ener-
 getic..... 3
 noisily vigorous.. 1
 noisily gorgeous.. 1
 richly vigorous... 2
 cheerfully rich... 1
 richly energetic.. 1
 gay..... 3
 cheerfully pomp-
 ous 1 * L.
 Total..... 25
 Corrected 24
 Total 35

quietly sedate..... 1
 daintily quiet..... 2
 peacefully quiet... 4
 cheerfully sedate. 3
 sickishly peaceful 1
 tenderly quiet..... 2
 cheerfully tranquil 1
 tranquil..... 2
 cheerfully gay..... 1 * Wg.
 vigorously ener-
 getic..... 1 * Hs.
 vigorously rich... 1 * St.
 noisay..... 1 * Mn.
 gaily energetic.... 2 * Gn. L.
 noisily energetic.. 1 * Go.
 cheerful..... 1
 daintily gay..... 1
 Total..... 25
 Corrected 19
 Total 29

peacefully sad..... 3
 sedately sad..... 2
 sedately rich..... 3
 pompously rich..... 6
 stately rich..... 2
 pompously digni-
 fied..... 1
 pompously quiet... 2
 pompously im-
 pressive 1
 pompously gloomy 1
 sombre..... 1
 pompous.. 1
 gorgeously rich..... 1 * Hs.
 Total..... 25
 Corrected 24
 Total 34

As was to be expected, the results of the final experiment proved far more conclusively the truth of the hypothesis advanced regarding those portions of the color spectrum which are respectively *exciting, tranquilizing and repressing*.

The most significant fact appearing from the investigation is the possibility of demonstrating that a given sensory stimulus has, for normal sense perceptions and under ordinary conditions, an affective character which *remains constant regardless of any subjective attitude of the sensibilities toward that stimulus*.

For example, we find among the responses to scarlet: 'gay,' 'noisy,' 'exciting,' 'energetic,' 'loud,' etc. All of these responses indicate that the affective character of that color is exciting, no matter what the subjective attitude may be toward it.

Obviously, the affective character of every color perception is

made up of the combined influences of *hue* and *luminosity*. Under the ordinary circumstances of life, the mere presence of light acts as an *exhilarating* influence, while darkness, or the absence of light, acts upon the sensibilities as a *depressing* influence.

Apart from luminosity, *hue* enters into the hue stimulus with its own peculiar influence. The subjective response to color stimulation has little, if any, significance in determining the affective character of such stimulation, since subjectivity is an inconstant factor that is wholly governed by the condition of nerves. The objectivity of stimulation must, however, remain constant, and it was in an effort to determine the *nature of this constant of objectivity*, upon which any esthetic of color must rest, that the foregoing experiments were undertaken.

A CURIOUS SECONDARY VISUAL PHENOMENON RESULTING FROM A STIMULATION OF THE MACULAR REGION.

BY DR. J. C. HUBBARD,
Clark University.

The effect about to be described may be observed with any feeble source of light viewed against a dark ground, but is most quickly and definitely seen under the following circumstances.

If a patch of soft red color, such as a ruby lamp wrapped with tissue paper, be viewed in a dark room, diffuse brushes of bluish tint are seen, apparently spreading laterally from it. With the right eye alone the brushes seem to extend to the right of the source, and with the left eye, to the left. This effect was first observed by the writer after a visit to an oculist, the pupils having been distended by atropine. The eyes were much fatigued by bright sunlight and on entering

a dark room the effect above mentioned was startlingly apparent. After the eyes had returned to normal condition the effect was not so pronounced, but the brushes were easily observed and have been shown to many friends. A brief study of the effect has been made and is here summarized.

Shape and appearance of the brushes. A soft, circular patch of ruby light, about 7 cm. in diameter, is first chosen. The observer is placed at a distance of perhaps 3 meters; the following effects are observed with right eye alone open. Looking at the right edge of the source two symmetrical brushes *a, a*, are seen, Fig. 1, clearly outlined on the outside and shading off to a faint, uniform bluish haze in the space *o*. These brushes terminate at the point *p*, which is found to correspond to the position

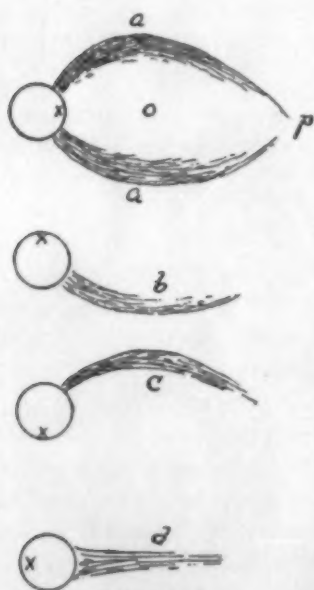


FIG. 1.

tion of the blind spot, for when the eye is turned to the left through exactly the distance $x\hat{p}$, the source disappears. If, now, the eye

be turned toward the upper portion of the disc, as at x (Fig. 1, b), a single brush appears, streaming away from the lower edge and curving to the right, and on turning the eye to the lower edge of the illuminated disc, a single brush appears at the upper side, as in c , Fig. 1. Finally, when the eye is turned to the left edge of the source, the brush takes the form of a column streaming away from the opposite side, as at d . The same effects are observed with the left eye alone, except that all the brushes or streamers go, apparently, to the left.

More quantitative results may be obtained if, instead of using a source of considerable area, a narrow, vertical illuminated slit is chosen. (The purpose is well served by allowing daylight to stream into a darkened room through the opening made by a nearly closed door, the brushes being made more prominent by viewing the slit so formed through a pinhole in a card held close to the eye.) To a person standing at a distance of 1 meter, looking directly at the slit, the streamers seem to reach a length of 25 to 30 cm. The brushes in this case (for monocular vision) are so close as to seem to start from the same area (3 or 4 cm. along the slit) and swell apart slightly before terminating at the position corresponding to the blind spot. If the right eye, for example, be turned to the right the two brushes separate, and recede further from the center of vision, one below and the other above, seeming to originate at the slit and curving to the right. They become longer and longer as the eye is moved to the right, their termination seeming to follow the position corresponding to the blind spot. At one meter distance from the slit, the greatest distance observed by the writer subtended by the origins of the brushes on the slit is about 20 cm. This occurs with the eye looking at a point about 10 cm. to the right of the slit. When the eye moves a very small distance to the left of the slit (2 cm.) the brushes merge into one, and for a small distance further the brushes disappear. The same description holds for the left eye, interchanging everywhere the word left for right, etc.

Superposing all the previous effects, and looking at them from the standpoint of apparent position in the retina, we may build up the conception embodied in Fig. 2. Let the circle represent an area about the fovea f , having a diameter of about one fourth the distance to the

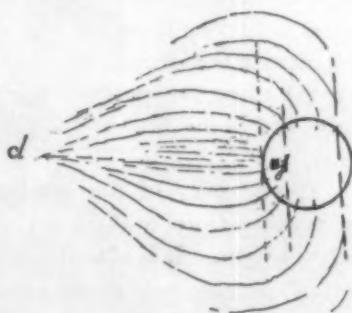


FIG. 2.

blind spot. Conceive the image of the slit to move across the circle. The brushes at any position will be approximately those coming from the circumference of the circle at the intersections of the slit image with the circle.

Duration of the Brushes. — With the eye fixed in one spot, the brushes die away in two or three seconds. They appear again on moving the eye slightly and are, perhaps, best seen when the light is turned on suddenly, the brushes flashing out instantaneously or possibly an instant later, seeming to grow with great rapidity to the position corresponding to the blind spot; then, if the eye is kept still, slowly dying away. If the light is periodically interrupted by a sector disc, the interruptions coming once or twice per second, the brushes are intensified, but not changed in character or position. Greater speed of the rotating disc gives results not in any way different from continuous illumination. It seems to be necessary to have the interruptions so slow that unconscious movement of the eye may take place. Prolonged observation makes the brushes difficult to observe. It then becomes necessary to expose the eye to general diffuse illumination, or to be in absolute darkness for a time.

The Color and Intensity of the Exciting Light and the Color of the Brushes. — Some preliminary experiments were made in which color screens were used. The results were not conclusive since such screens usually transmit a considerable portion of the spectrum. To secure a decisive test the eye was placed in the focal circle of a Rowland 21-foot concave diffraction grating spectroscope, with an electric arc at the slit. To the eye in this position the ruled surface of the grating appears uniformly illuminated by light as homogeneous as the light of the sodium lines. The intensity is controlled by the width of the slit. The brushes appear very faint at the extreme red. They increase in brightness as the eye travels up the spectrum and are brightest in the orange red and are nearly as bright in the yellow. Farther along the spectrum the brushes become overlaid by irradiating light, and in the blue and violet it is almost impossible to distinguish them.

The intensity of the brushes increases with the intensity of the exciting light, up to the point where the eye begins to be filled with diffused light. It is almost impossible to get light in the blue or violet part of the spectrum strong enough to show the brushes clearly without at the same time introducing irradiation, and possibly fluorescence. If the light is too feeble the brushes will not appear at all, though the question of intensity of light and excitation of the brushes has not been

gone into quantitatively. If a definite relation exists it seems probable that it will be found to depend upon fatigue effect.

The brushes are, for all wave lengths of exciting light, separately, or for white light, of a blue color.

Miscellaneous Tests. — A polarizing prism turned before the eye has no effect.

The effect of a diaphragm, such as a pinhole before the eye, is to cut down the illumination, making diffused light in the eye less, and throwing the brushes into a sharper relief, provided the intensity is not already too small.

Lenses held before the eye do not change the character of the brushes, except in so far as they change the position of the light image on the retina. The effect of moving a lens perpendicularly to the line of sight is the same as the effect of moving the source. The position of the brushes seems to be determined in all cases by the position of the image in the eye.

Discussion. — The foregoing tests lead to the following conclusion. An image of a source of feeble illumination consisting of any light of the spectrum upon the retina at, or very near to the yellow spot, produces the sensation of curved tufts or brushes of blue light extending from the image to the blind spot, and the position of these brushes depends *only upon the portion of the retina illuminated*. The intensity of sensation depends upon the intensity and wave length of the exciting light, upon movements of the image upon the retina, and exhibits a fatigue effect.

The phenomenon here described was studied and diagrams similar to Fig. 2 had been drawn when the writer found a strikingly analogous diagram in Quain's *Anatomy*, 10th ed., Vol. III, Pt. III., 'Organs of the Senses,' p. 40. The diagram is a 'magnified view of the innermost layer of the retina, showing the bundles of the optic nerve fibres radiating from the papilla' and is after Merkel.

On looking at this diagram one is driven to the conclusion that there is a connection between the effect described in this paper and the distribution of the optic nerve fibres. It would seem quite possible that certain sensations, passing from the macular region along these fibres to the optic nerve, are capable of inducing secondary effects in portions of the retina along which they pass. The fact that this secondary effect is of a blue color may indicate that the mechanism of blue sensation is different, or partly different from that of other color sensations.

SUPPRESSION WITH NEGATIVE INSTRUCTION.

BY HERBERT SIDNEY LANGFELD,

Harvard University.

A series of experiments is in progress in the Harvard Psychological Laboratory which aims to compare the association and the reproduction of normal subjects under normal conditions with those of normal subjects under distraction, and with those of abnormal subjects. One of the features of the experiment is the requirement of a suppression. As the tests on the normal subjects without distraction are already completed, and throw some light on the nature and development of the suppression process, the results, which bear upon this process, will be set forth in the present paper.

The experiment was conducted in the sound-proof room of the laboratory. Visual stimuli, consisting of small pictures in black and white of simple objects such as animals, vegetables, utensils, etc., were employed. There was never more than one object or several of the same kind of objects in the same picture, except occasionally an inconspicuous background. The pictures were mounted on black cardboard, which could be slipped into grooves behind a small square window cut in a black upright board. A black shutter, which was worked by hand, concealed the picture. A lamp with a reflector illuminated the window of the instrument; the rest of the room was in semi-darkness. The subject was seated directly behind the lamp and about one and one half feet from the picture.

The instructions for the A-tests were: "Shortly after you hear the word 'now' a picture will be exposed in the square opening. You are to speak the first word suggested to you by the object in the picture, unless it is the name of this object. You are not to name the object, but you may describe it or name any of its parts. For example, if it is a cow you may say small, old, head, etc. After the word is spoken you are to give the results of a careful introspection. Pay particular attention to the processes of suppression and association and to the imagery."

Ten pictures were shown and then the R-tests were begun, the pictures being given in the same order as before. The instructions were: "You will see the same pictures again. Try to give the same

association you gave before, but if another word should come up, you are not to inhibit it. As before you are not to name the object."

The time both for the A- and the R-tests was taken with a stop-watch. This was measured from the opening of the shutter to the first sound of the spoken word. There were sixty pictures in all, so that the experiment extended over six hours. With a few exceptions a week intervened between each series of ten pictures. Eight subjects took part in the experiment, all teachers or students in the department. They will be designated as A, B, C, D, E, F, G, H.

SUBJECT A.

A = association test, R = reproduction test, R.T. = reaction time, k' = any kinæsthetic imagery, k'' = kinæsthetic imagery of the name of the picture, v = visual imagery, a = auditory imagery, S.S. = successful suppression, S.R. = successful repetition.

A.			R.		A.				R.				A.	R ¹
No.	R. T.	m. v.	R. T.	m. v.	k'.	k''.	v.	a.	k'.	k''.	v.	a.	S. S.	S. R.
1	1.2	.44	1.3	.21	10	8	4		4	3	2		10	6
2	1.3	.24	1.2	.22	5	5	2		4	2			9	5
3	1.2	.24	1.3	.6	7	3	2		11	4			8	5
4	1.7	.45	1.1	.19	7	5	4		3	2			10	7
5 ²	1.1	.18	1.	.24	5	4	0		3	2			8	7
6	1.1	.14	.8	.14	4	3	1		2	2			8	8
Av.	1.2	.28	1.11	.25	Per cent. of successful tests :								91%	65%

¹The S.R. and the imagery other than k'' will not be discussed in this paper.

^a No. 5 and 6, unless otherwise marked, contain only nine reactions.

SUBJECT B.

A.			R.		A.				R.				A.	R.
No.	R. T.	m. v.	R. T.	m. v.	k'.	k''.	v.	a.	k'.	k''.	v.	a.	S. S.	S. R.
1	2.1	.27			6	5	I	4					10	
2	1.3	.18			7	6							10	
3	1.1	.15	1.1	.14	10	10			4	3			10	7
4	1.1	.14	1.1	.24	9	8			5	5			9	6
5	1.3	.23	1.1	.21	6	5			4	4			9	8
6	1.4	.26	1.3	.21	14	4	I		7	4			9	6
Av.	1.38	.2	1.15	.2	Per cent. of successful tests :								98%	71%

SUBJECT C.

No.	A.		R.		A.				R.				A.	R.
	R. T.	m. v.	R. T.	m. v.	k'.	k''.	v.	a.	k'.	k''.	v.	a.	S. S.	S. R.
1	1.7	.38	1.6	.34	5	4	2		3	0	1		9	3
2	1.7	.28	1.3	.30	9	7	2		4	3	0		10	7
3	1.7	.26	1.5	.44	5	3	1		2	1	1		10	8
4	1.5 ²	.32	1.3	.36	2	2	0		1	0	1		8	5
5	1.1	.25	1.1	.45	2	2	2		1	1			9	9
6 ¹	.9 ³	.18	1.3	.36	3	3	0		1	0			8	4
Av.	1.43	.28	1.35	.37	Per cent. of successful tests :								96%	68%

¹ A month elapsed between No. 5 and 6.² Contains only nine reactions.³ Contains only eight reactions.

SUBJECT D.

No.	A.		R.		A.				R.				A.	R.
	R. T.	m. v.	R. T.	m. v.	k'.	k''.	v.	a.	k'.	k''.	v.	a.	S. S.	S. R.
1	1.6	.26	1.5	.23	8	5	2		1	1			10	4
2	1.3	.18	1.2	.24	7	7	2		2	2			10	6
3	1.4	.32	1.2	.24	5	5			1	1			10	4
4	1.3	.16	1.0	.12	1	1			3	3			9	9
5	1.1	.19	.9	.1	1	1	1		1	0			8	9
6	1.2	.16	1.1	.16	2	2			0	0			9	5
Av.	1.31	.21	1.15	.18	Per cent. of successful tests :								96%	64%

SUBJECT E.

No.	A.		R.		A.				R.				A.	R.
	R. T.	m. v.	R. T.	m. v.	k'.	k''.	v.	a.	k'.	k''.	v.	a.	S. S.	S. R.
1	1.9	.56			1	5	1	3					10	
2	1.4 ¹	.16	1.3	.26	3	3			4	4	1		7	8
3	1.5	.28	1.3	.24	3	3	3		2	2	1		10	7
4	1.6	.20	1.2	.16	4	4	2		2	2	1		10	8
5	1.3	.20	1.0	.08	10	9	1		7	6			8	7
6	1.4	.31	1.3	.39	4	4			6	5			9	9
Av.	1.51	.28	1.22	.23	Per cent. of successful tests :								95%	83%

¹ Contains only nine reactions.

SUBJECT F.

No.	A.		R.		A.				R.				A.	R.
	R. T.	m. v.	R. T.	m. v.	k'.	k''.	v.	a.	k'.	k''.	v.	a.	S. S.	S. R.
1	1.5	.26	1.3	.26	10	5			8	3			8	7
2	2.0	.72	1.7	.37	6	5	4		15	7	5		8	5
3	1.5	.82	1.4	.34	7	5	1		8	7			7	7
4	1.5	.56	1.3	.30	15	6	1		11	4		1	9	9
5	1.6	.54	1.1 ¹	.20	11	9	2		7	4			8	5
6	1.6	.58	1.1	.21	11	7			10	7			9	9
Av.	1.6	.58	1.31	.26	Per cent. of successful tests:								84%	74%

¹ Contains only eight reactions.

SUBJECT G.

No.	A.		R.		A.				R.				A.	R.
	R. T.	m. v.	R. T.	m. v.	k'.	k''.	v.	a.	k'.	k''.	v.	a.	S. S.	S. R.
1	2.5	.66					1						10	
2	1.8	.20											10	
3	1.6	.32	1.1	.26			2						9	10
4	1.7	.44	1.1	.23									9	9
5	1.4	.22	.9	.10	1		1				1		9	9
6	1.3	.32	1.0	.24									9	8
Av.	1.71	.36	1.02	.21	Per cent. of successful tests:								96%	95

SUBJECT H.

No.	A.		R.		A.				R.				A.	R.
	R. T.	m. v.	R. T.	m. v.	k'.	k''.	v.	a.	k'.	k''.	v.	a.	S. S.	S. R.
1	1.7	.41	1.2	.18			1						8	6
2	1.6	.18	1.3	.16			1						10	7
3	1.7	.22	1.6	.32			4				3		10	6
4	1.4	.20	1.3	.22			7				5		10	8
5	1.5	.16	1.1	.12			2				2		8	7
6	1.6	.36	1.1	.10			2				1		9	6
Av.	1.58	.25	1.26	.18	Per cent. of successful tests:								95%	69%

An examination of the figures of the column under successful suppression (S.S.), which give the number of times the subject refrained from reacting with the name of the object, shows that in very few instances was the negative instruction not followed. The percentage of failures for the sixty tests range from 2 per cent. to 9 per cent. in the entire series, except in the case of F, who shows 16 per cent. This subject differs from the others also as regards the m.v., which is much greater and it is possible, judging from these facts and from

observation, that his attention, either from lack of interest or from fatigue, was not the best he could give.

As the actual inhibition of the spoken word is practically perfect from the beginning, in order to study the development of the process, we shall have to examine the tendency to name the object as revealed by the introspection on the kinæsthetic imagery. The question has been left open as to whether at any given time the subject means kinæsthetic imagery of the articulatory process or actual sensations in the organs of speech. So near the border of image and sensation, a judgment as to which is being experienced would only have value after a very long and special study by means of careful introspection. In column 6, under kinæsthetic imagery (k'), are tabulated all instances of such imagery whether of the name of the object or of an associated word. In column 7 (k'') are only those instances of the imagery concerned with the name of the object. It is this column which is of interest to us at present. In four of the six tables, which show kinæsthetic imagery, the amount decreases more or less gradually. This is proof of an increased power of suppression with practice. F is again an exception. Both he and E show a decided increase. Individual differences are to be expected. It is quite possible that they are of such a strong kinæsthetic type that only very long practice would overcome this tendency.

The figures thus far examined show the change from week to week. If we turn now to a comparison of the amount of kinæsthetic imagery in the A-tests with that of the R-tests on the same day, we find in all but F (and G and H) a decided decrease in the latter tests. Here there is shown the effect of practice in suppressing the same word. The fact that the interval between the two acts of suppression (in the A- and R-tests) is short and that a definite reaction word has been partially established in the A-tests also helps the inhibition.

The only datum that H's introspection reveals is that he is of a decidedly visual type, which may account for the entire absence of kinæsthetic imagery. G adopted a more definite attitude toward the experiment than did the other subjects, which, without doubt, helped the suppression. We will return to a description of this attitude in the following account of the process of suppression.

We shall first select examples from the records of the introspection illustrating the different forms of suppression and then describe the general development as deduced from the entire data. The examples are from the A-tests.

I. *Comb . . . Hair.* "I recognized comb. Kinæsthetic image

of comb. Locked the muscles of the throat, after thinking that I must not say the word. Then hair came."

Sleigh . . . Ride. "Recog. sleigh. Kin. image of sleigh. Thought I should not say it. Locked muscles and then said ride."

II. *Pump . . . Water.* "Recog. pump. Searched for word. Kin. image of pump. Thought that I must not say it."

Bridge . . . Lock. "Recog. bridge. Kin. image of bridge. Thought that was not the word to be uttered."

Bird . . . Sing. "Kin. of bird. Active suppression. Thought that I must not say it."

III. *Knife . . . Boy.* "Recog. pen-knife. Kin. image of pen-knife. Active suppression by slight locking of the muscles of the throat. Kin. image of boy. Feeling that it was right and said it."

Rake . . . Garden. "Kin. image of rake. Suppressed it by closing the mouth and putting the tongue against the roof of the mouth. Then thought of hoe. Don't know why I did not say it. Then said garden."

Hat . . . Tooth. "Recog. hat. Kin. image of hat. Locked the muscles and said tooth."

IV. *Pear . . . Eat.* "Recog. pear. Thought it was not to be named and said eat."

Car . . . Street-car. "Idea of car. Recalled that I must not say it. Was about to say trolley, when I saw that it had no pole and so said street-car."

Bed . . . Sleep. "Recog. bed. Thought that I must not say the name and the word sleep came."

Cannon . . . Gun. "Idea of cannon. Recalled that I was not to say cannon, so said gun."

V. *Clock . . . Move.* "Recog. clock. Kin. image of clock. Suppressed it by turning to the details of the hands of the clock."

Cards . . . Play. "Kin. image of cards. Suppressed it by turning to details of the cards."

VI. *Car . . . Ride.* "Recog. car. What could I do with it? Ride."

Cannon . . . Fire. "Recog. cannon. Idea of how to use it."

Tree . . . Shade. "Recog. tree. Thought of the appropriate use of it."

Sleigh . . . Ride. "Recog. sleigh and thought of its appropriate use."

VII. *Horse . . . Cow.* "Kin. image of horse. As to the suppression, the word simply did not come. Something providential seemed to prevent it."

Clock . . . Time. "Kin. image of clock. No voluntary suppression."

Collar . . . T-tie. "Kin. image of collar. No voluntary suppression."

Chair . . . Rocker. "Strong tendency to say chair. Inhibition seemed automatic."

Upon examination of the above introspection, we find all forms of suppression from a fully voluntary act to a purely automatic reaction. In all cases the subject begins in the attitude of the negative and positive instructions. As the series progresses, this attitude or 'Einstellung' is less vivid in consciousness. No systematic introspection of the fore-period was required, so that it does not appear in the above. In the first group (I.) there is the recognition of the word, with a tendency to utter it. Then there is the judgment that the word is contrary to the instructions and should not be uttered. A locking of the muscles of the organs of speech follows and the proper association is given. In group II. the judgment is sufficient for the inhibition and the locking of the muscles falls out, while in group III. the muscles are locked without consciousness of the instructions or of a judgment. In group IV. the negative instruction is recalled and is sufficient even to inhibit the kinæsthetic image. In group V. there is a conscious turning to something else, which helps to inhibit the kinæsthetic image. Neither in this group nor in group VI. is there a recall of the instruction or a locking of the muscles. In the latter group a definite attitude, one might say an artificial attitude, is assumed, by which the range of associations is limited to those answering a definite question. This was the attitude of G, which was referred to above. In VII. the process of uttering the word goes as far as the kinæsthetic image, but there is an automatic inhibition. Finally, immediately upon recognition of the picture the association is given. This is the complete automatic suppression. It was not deemed necessary to give examples of this form.

It must not be supposed that the subjects showed this gradual development. The different forms are scattered throughout the different days and the different subjects. From our knowledge of the shortening of the voluntary act into the automatic reflex in other spheres, we can conjecture how it would be in the case of one exercising the power of suppression for the first time, and from the above we can gain an idea of the probable number of stages and the manner in which they present themselves to consciousness.

The reaction times show little of interest as regards the subject of this paper. There is in general a decrease from day to day. In all

but a few cases the R time is shorter than the A time. This decrease is probably due partly to greater practice in the suppression; it is also due to the effect of practice in association and to the fact that in the R-tests the recognition of the picture is more rapid. There should be a coördination between the decrease in the reaction time and the decrease in the amount of kinæsthetic imagery. This we do not find. If the only difference between two tests is the absence of the kinæsthetic image in one of them, the test without the image will naturally have the shortest reaction time, but the latter test may have intermediate associations or a seeking for an association, which the other test does not have, in which case its time will be longer.

It is often possible to trace the effect of the inhibition caused by the negative instruction beyond the words actually covered by the instruction. We can thus gain some idea of its sphere of influence. It will be remembered that the subject was told he could name any part of the picture or could describe it. Hardly ever was this done. The associations were, as a rule, away from the picture. The majority of the words were nouns or verbs. Generic names were rare. Adjectives were almost never employed. In fact we have instances where they came to the mind of the subject, but were not used. In the association *Fish . . . Water*, the introspection says: "The fish seemed very small and I thought of a very small fish." Again, *Bed . . . Child*, "Recognized bed. Thought it a rather small bed. Thought of its purpose. Had a visual image of a child in bed and said child." To the association *Teeth . . . Gums*, the subject gave: "Kin. image of false teeth. Should have said these words. I don't know how gums got in." There are several instances in which a word was suppressed because it was either an element of the compound name of the picture or a compound word of which the name of the picture was one of the elements. To the association *Car . . . Track* was said: "I almost said car, then trolley. I gave track, feeling the assonance between the tr of trolley and that of track." Two subjects reacted to the picture *Strawberries* with *Fruit*. One of the subjects said: "I recognized strawberries and suppressed the kinæsthetic image of the word. I thought of berries, but suppressed it because it seemed too closely related to the name." The other subject said: "I had a kinæsthetic image of strawberries. I suppressed straw and almost said berries. Then there was a feeling of confusion before fruit came." The introspection to the reaction *Drum . . . Beat*, reads: "I recognized drum and the sticks on it. I thought of drum-major, but it did not seem to be the word I wanted." To the reaction *Foot . . . Shoe*, the subject gave: "I recognized foot and

thought of saying bare-foot, but it seemed too much like foot and I said shoe." To the reaction *Eye . . . Shoot*, the introspection reads: "I recognized eye and had a kinæsthetic image of bull's-eye, but could not say it." There is a good example of where an idea is suppressed because it occurs with that of the picture. To the reaction *Strawberries . . . Eat*, the subject said: "I recognized strawberries and thought of strawberries and cream, but said eat." There is also an instance where the name of a part of the subject is suppressed. The reaction was *Foot . . . Shoe*. The subject said: "I recognized foot and had a kinæsthetic image of toe, but could not say it." In an A-test the picture clock was named. In the R-test the subject said: "I recognized clock, but could not get anything. It was very queer. Then I remembered that I had named the object and so said clock." In another instance the name of the object, which had been given in the A-test, was entirely suppressed with the exception of its first letter in the R-test. In an R-test the subject gave *Tree . . . Tree* for *Tree . . . Apple*. He said: "I recognized tree and had the idea of an apple, but suppressed it. I don't know why." The reason probably is that the word apple had previously been suppressed in an A-test when it was the name of a picture. As a last example of the force of the suppression may be cited the reaction *Top . . . Boy*. The introspection reads: "Top was coming in when cot was substituted as an auditory-kinæsthetic image. Boy (boycot) succeeded." Here not only was top suppressed, but the similar word cot.

SUMMARY.

It has been clearly shown in the experiment just described, that a negative instruction fulfils the purpose for which it is intended. There are a positive and a negative 'Aufgabe,' both of which are carried out. The negative 'Aufgabe' has acted as a block, cutting out a definite association. In all positive attitudes, one can say that there is also a negative quality, in as much as the way is blocked for all associations not included in the instructions. The difference here is that the negative attitude is a conscious one at first and directed toward a definite goal.

We have also seen evidence of the force of the suppression, which not only inhibits the name of the picture, whenever there is a tendency for it to be pronounced, but frequently inhibits words closely related to the picture. This is similar to the inhibition, so frequently mentioned by Freud, of thoughts which are unpleasant to the subject.

Finally, the general development of the suppression process, especially as shown in the decrease of the kinæsthetic image, tends to prove that the suppression can be strengthened by practice.

PSYCHOLOGICAL LITERATURE.

STATISTICAL METHODS IN PSYCHOPHYSICS.

The Application of Statistical Methods to the Problems of Psychophysics. F. M. URBAN. Philadelphia: Psychological Clinic Press, 1908. Pp. ix + 221.

The material of this investigation was obtained in a series of experiments with lifted weights. The weights used were brass cylinders, which could be adjusted very exactly by filling with melted paraffine; the range of adjustment was wide enough to include the largest and the smallest weight to be used. These cylinders — an improved form of the Cattell weights — show very little variation and are influenced only to an inconsiderable extent by changes of temperature and moisture of the air. Great care was taken to keep all the conditions constant. The space error was eliminated by a device which placed the weight always in the same position relative to the hand; the time error was kept constant by regulating the motion of the hand by the beats of a metronome. A standard weight of 100 gr. was compared with weights of 84, 88, 92, 96, 100, 104 and 108 gr., the standard always being lifted first. Only one standard was used, but with this a greater number of experiments was performed than ever before with one standard. With three of the seven subjects 3,150 experiments each were made and with the remaining four subjects 2,100 experiments each, bringing the total up to 17,850 experiments. All conditions accessible to control, which were known or supposed to influence the judgment of the subject, were kept scrupulously constant; but no comparison stimulus was found on which the same judgment was always given, although some of the differences used are considerably greater than the threshold. This suggested the following view.

If the subject is required to compare two stimuli under constant conditions, his judgment will vary, so that one cannot possibly foresee the result of any particular experiment. The passing of a judgment on the comparison of two stimuli, therefore, has the formal character of a chance event like drawing a ball from an urn which contains balls of different color; and it is supposed that there exists a certain definite probability as regards every judgment that it will be given on the comparison of two stimuli. If the judgments *greater*, *smaller*

and *equal* are admitted, passing a judgment on the comparison of two stimuli may be compared to drawing a ball from an urn which contains white, black and red balls in certain proportions, about which, however, we know nothing beforehand. These probabilities vary with the conditions of the comparison and they are, generally speaking, different for different individuals. Experience shows that if a standard stimulus is compared, under the same conditions, with stimuli of different intensity, the probabilities of the different judgments vary in a certain way. The probability of the judgment *greater* increases, and that of the judgment *smaller* decreases with increasing intensity of the comparison stimulus, whereas the probability of the equality cases increases at first, only to decrease after having reached a certain maximum. The author undertakes to build up the whole theory of psychophysical measurements on this notion of the probability of a judgment.

These probabilities are *a priori* absolutely unknown and their determination is the object of experimentation. This is done by observing the relative frequencies of the different judgments in large groups of experiments. The next problem is to find out whether these probabilities remain constant or vary in the course of experimentation. The answer to this question is based on the coefficient of divergence of Lexis and Dormoy. The determination of this quantity requires not only a long series of experiments, but a considerable number of extended series of experiments, and this is why it was necessary to obtain such a large number of judgments. The values of the coefficient of divergence show that, at least with some subjects, one is justified in concluding that the underlying probabilities of the different judgments did not change. It comes out very clearly that those subjects who had previous psychological training give the smallest values of the coefficient of divergence, from which the important conclusion may be drawn that an individual is a satisfactory subject for psychological experiments of this kind if the numbers of relative frequency of the different judgments show a normal dispersion, *i. e.*, give values of the coefficient of divergence only slightly different from unity. It seems that this quantity gives an objective criterion for answering the question whether a subject acquired sufficient training in the preliminary experiments.

The next chapter deals with the method of just perceptible difference. This method is the oldest of all psychophysical methods and, in spite of all the criticism it has met, it is the only one to be used with advantage for clinical observations and in all cases where only a rough but handy determination of the sensitivity of a subject is required. This method has stood the test of practical application; and the only question justified in view of this fact is, What do we determine by this method?

The way in which it is analyzed may be seen from an analysis of the notion of the just imperceptible positive difference. In determining this quantity one has to start from comparison stimuli which are judged to be greater than the standard; and diminish them gradually until a stimulus is found, which is not judged to be greater than the standard, *i. e.*, one on which either one of the judgments *smaller* or *equal* is given. The first stimulus of a series on which the judgment greater is not given, is a determination of the just imperceptible positive difference. The single judgments are chance events, and the fact that a certain stimulus of a series is obtained as a result of a determination of the just imperceptible positive difference is a compound event, the probability of which can be given in terms of the probabilities of the judgment greater for the stimuli used. In this way formulæ are found for the most probable values of the just perceptible and the just imperceptible positive and negative differences, which are expressed entirely in terms of the intensities of the comparison stimuli used and of the probabilities which they give to the different judgments. It is seen that the individual result of the determination of either one of these four quantities depends on the stimuli used, but this influence is eliminated if different series are used. The number of different series need not be very great in order to give a rather satisfactory approximation. The final result of a considerable number of determinations of the just perceptible positive difference is equal to that of the just imperceptible difference and the average of a small number of determinations is a more exact determination of the intensity of the comparison stimulus for which there exists the probability one half that the judgment greater will be given. In the same way it is seen that the final results of a great number of determinations of the just perceptible and of the just imperceptible negative difference coincide, and that they determine the comparison stimulus which gives to the judgment smaller the probability one half. These two values are called the threshold in the direction of increase and of decrease respectively; they determine an interval inside of which neither one of the judgments greater or smaller has a probability equal to or exceeding one half. This interval is called the interval of uncertainty and the comparison of the accuracy of sense perception of different individuals or of the same individual at different times or under different conditions is based on it. The interval of uncertainty is a purely physical quantity, and the proof of this fact does away with the supposition that we measure psychical quantities by the method of just perceptible differences. The truth of the proposition that we determine in this method the stimuli for which

there exist the probabilities one half that the judgment greater and smaller will be given, was suspected for a long time, but no demonstration has been given before. It is interesting to notice that the proof is by no means very difficult.

The theoretical deductions are tested on the material obtained in the experiments and the results of the calculations coincide very closely with the data of the observations.

The fact that the probabilities of the different judgments vary with the intensity of the comparison stimuli suggests the view that they are functions of the intensity of the stimuli. A mathematical expression which gives this relation between the intensity of the comparison stimuli and the probability of a certain judgment, is called the psychometric function of this judgment. The mathematical formulation of the problem is this: The values of an unknown function are given for a certain number of values of the independent variable; it is required to determine the function (or at least other values of it) on the basis of these data. The simplest way of solving this problem is to regard these probabilities as algebraic functions of the comparison stimuli and to treat the data by Lagrange's formula. The problem of interpolation is frequently met with in psychology and in this chapter, which is easily accessible to psychologists, one may look for advice in similar cases. The upper and lower limit of the interval of uncertainty are calculated by interpolation and it is seen that the results agree very well with those obtained in the method of just perceptible differences. It seems, however, that the author does not lay sufficient emphasis on the differences between these two methods, because in an actual application of the method of just perceptible differences in its traditional form the stimuli are presented to the subject in a certain order and the subject cannot be prevented from knowing it. This knowledge on the part of the subject causes all those influences which were studied by former investigators, and which are entirely absent when the stimuli are presented in random order as is the case of the method of constant stimuli.

The author then gives a discussion of the notion of the point of subjective equality as defined by means of the equality judgments alone. The arithmetical mean, the median and the mode are studied and found useless for this purpose, either because they cannot be determined objectively from the data, or because they give a probability exceeding one half to one of the other judgments. The determination of the mode, however, gave the remarkable result that the maximum value of the probability of the equality judgments can be used as a

measure of the accuracy of sensation just as well as the interval of uncertainty. Among the methods of calculating the mode the author also mentions the way of setting up the equation of the psychometric function by Lagrange's formula and finding the maximum by differentiation. This part of the book makes a rather fanciful impression, because there is obviously no balance between the result obtained and the amount of work devoted to it. It seems that the author had in mind to set up these equations for all his seven subjects, in order to investigate whether there is any regularity in the numerical values of the coefficients: but that he gave up this task either because the work of setting up these equations was too great or because the results obtained did not warrant going any further with this laborious enterprise.

The last chapter contains a discussion of the scientific nature of psychophysical problems.

SAMUEL W. FERNBERGER.

UNIVERSITY OF PENNSYLVANIA.

FEELING.

Die Grundformen der Gefühle. N. ALECHSIEFF. Psychologische Studien, 1907, III., 156-271.

The author defines feeling as a psychical process which is subjective and not localizable. Earlier writers are criticized in that they have used too exclusively either the method of impression or that of expression. In this work an attempt is made to obtain, side by side, a close introspective account and the objective expression in pulse and breathing. The sphygmograph is used for the pulse. The kymograph is rotated at the rate of 8.7 mm. per second. For the heart rate, the average length of the pulse during each breath and also the average length during each period covered by a given introspective condition are tabulated. Only a short curve before and after the stimulus is used. This method is, in some ways, an improvement over that which measures the number of pulse-beats in each period of 10 seconds, but seems to me entirely insufficient to show accurately even a long, violent reaction; and, with the short stimuli used in this investigation, there is practically no reliability at all.

In discussing the normal condition, Alechsieff finds that a feeling must have a certain strength to cause a physiological response. He refers to the Traube-Hering wave and says it can easily be distinguished from the feeling-reaction. This is the last we hear of it, however, and there is no attempt to make such a distinction later, although many of the changes in his tables are probably due to this

cause. He finds that breathing influences the results in that there is a breathing wave in the heart-rate, and increased breathing usually causes a faster pulse, decreased breathing a slower pulse. Yet he never explains a reaction in this way, and says the effects on the pulse by voluntary variation of breathing are not comparable with those produced by feelings. One might observe that the changes of breathing itself are often much greater in his tests for feeling than in those with voluntary variation.

The first feeling studied is that of activity, which one has with concentration of attention or expectation. According to the introspection of the subjects, this is a mixture of strain and excitement, and the dominance of one or other of these determines the objective expression. As a stimulus for strain he prefers a succession of two metronome-beats, since the subject would merely have to prepare himself to receive these passively. Introspectively the subjects reported two factors in the strain experience: (1) Strain sensations and (2) an unanalyzable something more, an inner mental strain. Likewise in relaxation they found sensations of release of the muscles and breathing and an unanalyzable experience opposed to that in strain. Physiologically, strain gave a restricted breathing and lengthened pulse, relaxation the opposite.

Excitement and rest were studied by suggesting that the subject place himself in such conditions. Introspectively, the subjects reported in these states more or less organic sensation and unanalyzable, inner, non-localizable factors of excitement and rest. With excitement, the breathing was faster and irregular, the pulse shorter and higher; with rest there were opposite effects. The author explains the disagreement among writers on the objective expressions of strain and the feeling of activity on the ground that they have worked with varying mixtures of strain and excitement without proper introspective analysis. One might ask whether such general confusion is not itself due simply to the fact that there is no real line of demarcation between the two.

Agreeableness and disagreeableness were studied by use of tactual, gustatory, olfactory, auditory and visual stimuli. Each is considered an unanalyzable non-localizable, inner condition. Agreeableness gave a quickened, shallow breathing and heightened, usually lengthened pulse. Disagreeableness gave a shortened, lowered pulse and variable breathing effects. Combinations of agreeable and disagreeable stimuli gave an alternation from one to the other — not a mixture.

Inconsistencies in the above objective expressions are often ex-

plained as due to the presence of other feelings. The article is perhaps better than some others that have appeared on the subject, but seems to me inaccurate and inadequate.

JOHN F. SHEPARD.

UNIVERSITY OF MICHIGAN.

REPRODUCTION AND ASSOCIATION.

Die Reproduktion und Assoziation von Vorstellungen. Eine experimentell-psychologische Untersuchung. ARTHUR WRESCHNER. Leipzig: J. A. Barth, 1907-1909. (Ergänzungsband III., Zeitschrift für Psychologie und Physiologie der Sinnesorgane.) S. vii + 599.

Dr. Wreschner has made a systematic series of experiments upon association reaction-times. His book consists essentially of a description of the temporal relations and the qualitative contents of these associations, together with a discussion of their theoretical significance.

His apparatus was the Hipp chronoscope with the usual accessories. Fifteen of his reagents were 'educated' adults—ten men and five women, chosen from among the instructors and students at the university; five were 'uneducated' adults—three men and two women, chosen from the artisan class; and two were boys, *ca.* three and six years of age. His material consisted of 188 adjectives, 200 names of concrete objects, 147 abstract terms, and 141 verbs. These words were, for the most part, presented in auditory fashion; but in a few instances visual presentation was introduced. Three variations of procedure were employed: (1) In the first group of experiments, the reagent was allowed complete freedom in his choice of a reaction-word; and no stimulus-word was employed more than once in this series of (6,792) reactions. (2) Here, again, there was no curtailment of the reagent's freedom of choice; but certain stimulus-words, which had already been presented, were re-presented at later sittings. In some cases, the same word reappeared in eight different series; but in every instance an interval of at least a week elapsed between its successive recurrences, and it never appeared twice in the same context. It was hoped, by means of this variation of procedure, to determine the strength of the association between a stimulus-word and its reaction-word. There were 3,338 reactions in this group. (3) In the third series of (5,541) experiments, the reagent was required to form a prescribed sort of association,—opposition, co-ordination, subsumption, or the like.

1. The times required for free associations are exceedingly variable and irregular. Wreschner does not report his mean variations; nor

does he give any other data regarding the uniformity of his reaction-times. It seems safe, however, to formulate at least the following general principles. Age, sex, 'individuality' and degree of education of reagent, all play a part in influencing the duration of the process of association and reproduction. The following averages are reported: For 'educated' reagents, 1,437 σ ; for 'uneducated,' 2,562 σ ; men 1,543 σ ; women 2,248 σ ; children 3,348 σ ; 'educated' men 1,337 σ ; 'educated' women 1,707 σ ; 'uneducated' men 2,266 σ ; 'uneducated' women 2,791 σ . The character and content of the stimulus-word is also a factor. The average reaction-times for different adjectives varied between 1,709 σ and 2,328 σ ; for names of concrete objects between 1,893 σ and 2,293 σ ; for abstract terms, between 2,028 σ and 3,415 σ . The affective-tone of the stimulus-word also plays a part; and Wreschner is convinced that the reaction-time varies directly with the intensity of the affection.

Introspection shows that the process of apprehending the stimulus-word is extremely variable. The direction, as well as the concentration, of attention is of influence—distraction and expectation both giving rise to misapprehension. The content or meaning of the stimulus-word is a determining factor. The meaning may be grasped inaccurately or only approximately; we may seize upon a purely figurative or other highly specialized meaning; or we may recognize that it is ambiguous, and vacillate between its possible interpretations. And the reaction varies with all of these variable circumstances. The reproduction may be complicated by the presence of concomitant imagery or affections; and immediately preceding experiences frequently play a part in influencing the association. The reaction-word may come to consciousness in a purely automatic fashion, or it may be found only after a more or less deliberate search for it. The first reproduction to suggest itself is frequently rejected as unsatisfactory, and the search is continued; but it sometimes happens that farther search is fruitless, and that the rejected word is finally chosen. In many instances the reaction-word is not an adequate expression of the reaction-idea. The association itself may be simple (having but a single bond of union), or manifold; it may be direct or mediated by an intervening term. The length of the stimulus-word is of influence, in that monosyllables tend to reproduce monosyllables, while long stimulus-words tend to call up longer reaction-words. The reaction-word is usually chosen from the 'immediate environment' of the stimulus-word—thus one visual quality suggests another visual quality, the name of an animal is likely to be associated with the name of another animal, etc. The reagent

tends to choose an adjective in reacting to an adjective, an abstract term in responding to an abstract term. These 'symmetrical' reproductions, however, occur most frequently with rapid reagents; the reproduction tends to become more individual in proportion as the reaction-time becomes longer.

2. If it should happen that a given stimulus-word invariably arouses the same reaction-word, this would indicate that an exceedingly strong association obtains between the two words. Conversely, the number of different reaction-words with which the reagent responds on repeated presentation of the same stimulus-word may be taken as a measure of the number and relative strength of the reproduction tendencies which operate in competition with one another. Wreschner found that the variety of reaction-words decreased with progressive repetition of any given stimulus-word. This tendency toward a stereotyped reaction was greatest when adjectives, and least when abstract nouns were employed as stimulus-words. Educated reagents give a greater variety of reaction-words than uneducated; men excel women, and adults excel children in this regard. Two types of repetition of reaction-word are to be distinguished—one due to inherent strength of association, the other due to a dearth of other appropriate responses. In the former type, the repetition begins before the list of possible reaction-words has been exhausted; the serial order of responses assumes some such form as 1, 1, 1, 2, 2, 3, 4, 5. The latter type repeats only after running the gamut of possibilities, giving such a serial order as: 1, 2, 3, 4, 5, 5, 5, 5. Men tend to repeat once or twice, and then to employ a new word, thus: 1, 1, 2, 2, 3, 3, 4, 4; women tend to return to a former response after having abandoned it temporarily, thus: 1, 2, 3, 2, 1, 1, 1, 2. With the first two or three repetitions, there is a retardation, then a progressive acceleration of reaction; the former is held to be due to the occurrence of new responses, the latter to the recurrence of old responses. The reagent does not always recognize that his present reaction-word is identical with a former one; but when he is aware of the repetition, his reaction-time is lengthened. Variations due to sex, age, education, etc., occur here as in non-repeated reactions.

3. Several factors coöperate to determine the length of the reaction-time in circumscribed associations; but, in general, the reaction is accelerated in proportion as the circumscription is definite, or as the range of possible choice of response is limited. Thus the naming of something which is opposite to a given term required 1,496 σ ; the naming of the country which contains a given city required 1,535 σ ;

the naming of any city in a given country required 1,665 σ ; the naming of the author of a given book 1,737 σ ; and the naming of any book written by a given author 1,968 σ . The influence of education, of concomitant phenomena, and of content of stimulus-word is less in circumscribed than in free association.

In the theoretical discussion of his results, Wreschner subjects the traditional doctrine of association to a searching criticism, and shows that the 'laws of association' are inadequate to an explanation of his results. Those objective relations (coëxistence, immediate succession, and the like) which obtain between parts of our experience, and which we learn through experience itself, can never serve as a basis for all of our associations and reproductions; we must seek in our mental elaboration of experience for the origin of the relationships which give rise to the phenomena of association and reproduction. And it is in this working-over of experience, under the rubrics of apprehension, abstraction, analysis, apperception and the ascription of meaning, that he finds the factors which determine the course of our ideas and thoughts. It is not the objective state of affairs, but what we attend to in the objective state of affairs which constitutes the *Reproduktionsmotiv*. How do I elaborate my sensory experience; from what point of view do I apperceive it; what meaning does it attain for me? These are the essential factors in determining my associations and reproductions.

Wreschner's investigation is, in many respects, a thorough and valuable piece of work. His experimentation is ingenious and systematic; his discussion is sound and conservative, and his conclusions furnish an interesting confirmation of recent developments in psychological theory. The author's presentation, however, scarcely does justice to himself or to his work. The reviewer has already mentioned the fact that a mere statement of averages does not adequately describe a series of numerical data. There is an unfortunate tendency, throughout the paper, to elaborate minor points at tedious length, and to magnify the significance of minute variations in experimental findings (*vide* 'symmetrical associations,' S. 69 ff., and 'practice,' S. 316 ff.). In the opinion of the reviewer, the six hundred pages might have been condensed to less than one third of that number. There is no evidence that Wreschner is familiar with the extensive literature of his topic; he makes no attempt to bring his findings into relation with the results obtained by other investigators of the same problem. And what excuse can an author offer for his failure to provide an index for a book which runs into six hundred pages?

J. W. B.

MYERS' EXPERIMENTAL PSYCHOLOGY.

A Text-Book of Experimental Psychology. CHARLES S. MYERS, Lecturer in Experimental Psychology in the University of Cambridge, Professor of Psychology in King's College, University of London. New York: Longmans, Green & Co., 1909. Pp. viii+ 432.

The scope and purpose of this book is thus outlined by the author in his preface: "The literature of Experimental Psychology is now so scattered and so profuse that a student must have at his command a small library of books and periodicals if he wishes to pursue a course of independent reading."

"In endeavoring to supply this want I do not attempt to offer a 'systematic' psychology. On the contrary, I assume that the student is already familiar with the elements of general psychology. . . . I may appear at times to have laid undue stress on purely physiological and physical considerations in their relation to the problems of experimental psychology. But the ultimate object which has influenced me throughout has been to describe the methods and principles of psychological experiment, and to set forth the most important results that have been obtained in this field of research."

"The order of the chapters has been dictated by experience in teaching. I find it best to start with experimental work on sensation; this, on the whole, gives the student less difficulty, alike as regards manipulation and introspection. Owing to the fulness with which I have treated sensation the account of the experiments relating to the higher mental processes may possibly have suffered. I feel very strongly, however, that the best training for the beginner in experimental psychology lies in the field of sensation."

The book is not a text-book in the sense with which we have become so familiar in recent years. It is rather a combined text-book and laboratory manual. And one of its most commendable features is its ideal of keeping the lecture-room and the laboratory in close contact with each other throughout. The author does not aim to present a systematic discussion of psychological theory. He plans to do something for which, in the opinion of the reviewer, there is much greater need in modern psychology—to present a systematic statement of the results of psychological experimentation. And this statement is supplemented by exceedingly valuable chapters on the standpoint of experimental psychology, the specific energy of sensations, the statistical and the psycho-physical methods.

Seven chapters are devoted to sensation, one to reaction-times, and two to memory (the best presentation of this topic which we have in

the English language); then follow chapters on muscular and mental work, weight, local signature, sensibility and sensory acuity, experiences of identity and difference, binocular experience, binaural experience, visual perception of size and direction, time and rhythm, attention, and feeling. The last eighty pages of the book describe a series of laboratory exercises which are designed to illustrate and to supplement the discussions in the foregoing chapters.

Professor Myers has written an exceedingly valuable book. The style is clear and forcible, the presentation is conservative and up-to-date, and the bibliographical references are numerous and well-chosen. It is not too much to say that this volume should be in the library of every teacher and student of psychology.

J. W. B.

BOOKS RECEIVED DURING MAY.

The Psychology of Reasoning. W. B. PILLSBURY. New York & London: Appleton, 1910. Pp. ix + 306. \$1.50 net.

Theories of Knowledge: Absolutism, Pragmatism, Realism. LESLIE J. WALKER. (Stonyhurst Philos. Ser.) London & New York: Longmans, Green, 1910. Pp. xxxix + 696.

La Lutte Contre le Crime. J. L. DE LANESSAN. (Bibl. gén. des Sci. sociales.) Paris: Alcan, 1910. Pp. xx + 304.

Philosophie de l'éducation: Essai de pédagogie générale. EDOUARD RÖRICH. (Bibl. de philos. contemp.) Paris: Alcan, 1910. Pp. 288. Fr. 5.

La vraie éducation. PAUL GAULTIER. Paris: Hachette, 1910. Pp. xi + 283. Fr. 3.50.

NOTES AND NEWS.

PROFESSOR ARTHUR O. LOVEJOY, of the University of Missouri, has been appointed professor of philosophy in the Johns Hopkins University. He will enter upon his duties next September.

DR. W. V. BINGHAM, of Teachers College, Columbia University, has been appointed assistant professor of psychology and education at Dartmouth College.

DR. FREDERIC S. BREED has been called to the University of Michigan as assistant professor of education.

DR. ELIOTT P. FROST, now instructor in philosophy at Princeton University, has been appointed instructor in psychology at Yale University in place of Dr. Breed.

